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Section 19
GROUNDWATER

Groundwater is an important source of water for municipal, industrial, and agricultural uses in the Bear River Basin. This section describes groundwater conditions in the basin.

19.1 INTRODUCTION

Groundwater has been developed in varying amounts in all valleys of the Bear River Basin. According to the USBR's "Bear River Investigations, Status Report," in 1970[1] there were over 3,430 wells in the Utah portion of the Bear River Basin. Figure 19-1 shows the general location of groundwater aquifers in the basin. An aquifer is defined as a water-bearing stratum of fractured or permeable rock, sand, and/or gravel. A groundwater reservoir can be defined as an aquifer that acts much like a surface reservoir, in that it spills and stores water as the level in the aquifer rises and lowers.

The groundwater reservoirs in the Bear River Basin are generally full. They are fed from precipitation and river flow at higher elevations, and they discharge water at lower elevations through wells, springs, and seeps. New withdrawals from these reservoirs could impact surface water by decreasing the discharge of flowing wells and springs, reducing water supply to wetland areas, and/or decreasing baseflow in streams. The impacts on existing water rights from future groundwater withdrawals, as well as the surface system, need to be understood to prevent future groundwater development from adversely affecting current users.

Estimates of present groundwater uses in the Bear River Basin are shown in Table 19-1. Water use refers to water that is withdrawn, but not necessarily consumed.

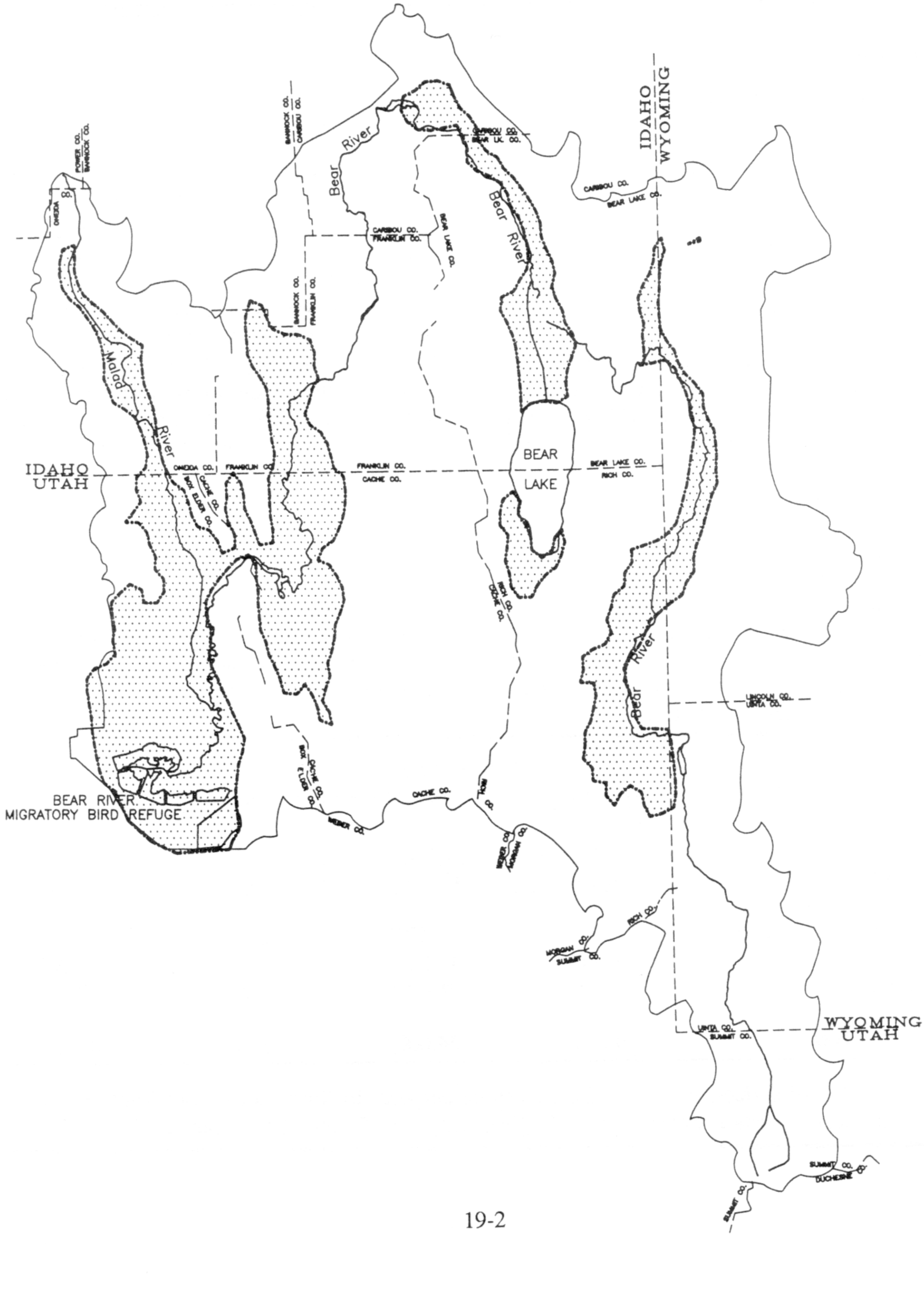
TABLE 19-1
PRESENT GROUNDWATER USE IN BEAR RIVER BASIN

	1990 Average Annual Use (AF)			
Type of Use	Rich	Cache	Box Elder	Total
Residential/Commercial	3,340	31,430[a]	15,500[b]	50,270
Irrigation[2]	3,000	13,300	6,000	22,300
Industrial	20	9,270[2]	1,020[2]	10,310
Total	6,360	54,000	22,520	82,880

[a]500 acre-feet of surface water used for residential purposes in North Logan (See Table 11-9).
[b]400 acre-feet of surface water used for Brigham City Golf Course (See Table 11-8).

FIGURE 19-1

GENERAL LOCATIONS OF GROUNDWATER AQUIFERS IN BEAR RIVER BASIN



19.2 SETTING

Groundwater conditions in the Bear River Basin will be discussed in three parts: The upper basin (Rich and Summit counties), Cache County, and Box Elder County.

19.2.1 Upper Basin

The principal water-bearing deposits are limited to the flood plain area along the Bear River and along the southern part of Bear Lake.[3] The groundwater aquifers are mainly deep, alluvial deposits that consist of alternating layers of gravel, silt, and clay.

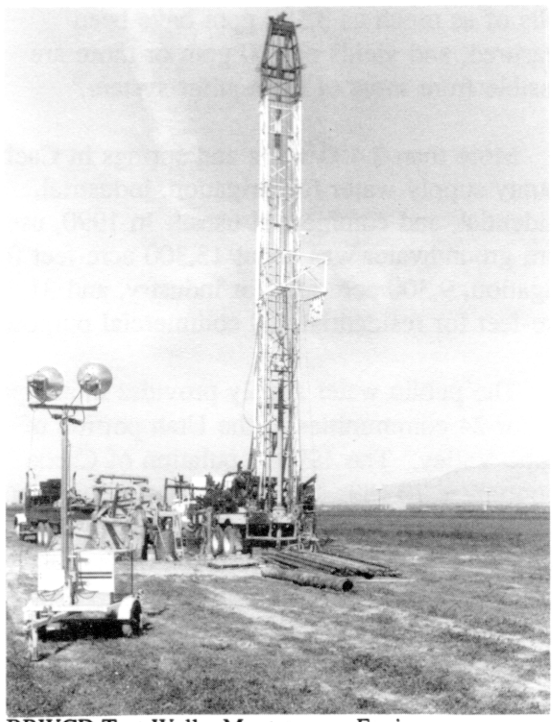
The adjacent mountain range area is underlain with clastic sedimentary rocks. These rocks are predominantly sandstone, quartzite, or shale, with some interbedded limestone or dolomite.[4] Wells in these aquifers generally have low yields. The yields vary from a few gallons per minute (gpm) to several hundred gpm in areas that are well fractured.

In the upper basin, the amount of groundwater use is small compared to the rest of the river basin. About 12 pumped wells are used for irrigation. The amount of water pumped is estimated to be 3,000 acre-feet/year.[5] At least five public water systems use groundwater--Randolph, Woodruff, Garden City, Laketown, and Bridgerland Village (west of Bear Lake). Total use for residential/commercial purposes is about 3,300 acre-feet/year. Groundwater use for other purposes, including livestock and for as many as 100 summer cabins in the mountains, is small by comparison.

19.2.2 Cache County

Although the entire drainage into Cache Valley is about 1,840 square miles (excluding the upstream Bear River drainage area), the valley itself occupies only about 660 square miles. About 300 square miles of this area extends north into Idaho. The Utah portion of Cache Valley covers the remaining 360 square miles.

Cache Valley is a structural basin bounded by faults on the east and west, and partly filled with sediments of Tertiary and Quaternary age. Strata of sand and gravel within these sediments make up the aquifers in this part of the basin. The adjacent mountain ranges are composed of carbonate sedimentary rocks which contain groundwater reservoirs. These reservoirs feed the numerous springs found along the edges of the valley.



BRWCD Test Well - Montgomery Engineers

The aquifers in Cache Valley consist of confined, semi-confined, unconfined, and perched types. At locations near the mountain front, aquifers are generally composed of coarse unconfined material. Groundwater in these regions is more easily recoverable than in other areas of the valley. At distances farther from the mountain front, layers of silt and clay begin to form confining layers that retard the upward movement of water.

Artesian conditions exist in approximately 200 square miles of the central part of the valley, and wells flow in an area of about 130 square miles. Pressure heads of most flowing wells are less than 40 feet, but heads as high as 62 feet have been measured. Depths to water are as much as 300 feet along the margins of the valley. Water table conditions exist near the edge of the valley and in a thin zone overlying the artesian areas in the central part of the valley. Perched groundwater exists in many locations in the valley.

The most productive aquifer system in Cache County is in the area along the east side of the valley between Smithfield and Hyrum. Yields to wells of as much as 3,500 gpm have been measured, and yields of 500 gpm or more are possible from most of the aquifer system.[6]

More than 2,400 wells and springs in Cache County supply water for irrigation, industrial, residential, and commercial uses.[7] In 1990, use from groundwater was about 13,300 acre-feet for irrigation, 9,300 acre-feet for industry, and 31,400 acre-feet for residential and commercial purposes.

The public water supply provides municipal use for 24 communities in the Utah portion of Cache Valley. The 1990 population of Cache County was 70,183. The valley has a good supply of high quality groundwater for municipal use. Public water systems supply much of the demand for dairies and meat packing industries.

Recharge to the groundwater system in Cache County occurs mainly within alluvial zones adjacent to the mountain front. Of the total calculated recharge, 47 percent originates as infiltration of precipitation that falls directly on the valley, or by infiltration directly from stream channels. Another 42 percent infiltrates from irrigation on croplands and other areas. The remaining 11 percent recharges the groundwater system by subsurface flow through faults, fractures, or solution channels. Total recharge to the Utah portion of Cache Valley is estimated to be 170,000 acre-feet per year.[8]

Groundwater discharge includes pumping from local wells, subsurface flow, seepage of water to streamflow, and evapotranspiration from high water table areas. Approximately 170,000 acre-feet of water is discharged annually in Cache County as shown in Table 19-2.

A 1990 report by the Bureau of Reclamation and Division of Water Resources (based on the 1971 USGS Study[6]) estimated that an additional 75,000 acre-feet/year of groundwater could be withdrawn from Cache Valley aquifers without significantly impacting surface supplies.[8] However, withdrawals of large quantities of groundwater will affect water rights and hydrodynamics of the groundwater system.

In an effort to gain a better understanding of current groundwater conditions, the Division of Water Resources and the Division of Water Rights have contracted with the U.S. Geological Survey to undertake a three-year cooperative study (to be completed in the fall of 1993) to:

1. Assess current conditions in Cache Valley in terms of recharge, movement, and discharge of groundwater, water levels, groundwater quality, and volumes of water in storage, and to document changes in conditions since the last study in Cache Valley in 1967-69;

2. Better define the groundwater system and how its components interact, with emphasis on groundwater/surface water interactions;

3. Estimate the effects of additional groundwater withdrawals in various geographic patterns, on water levels, streamflow, spring discharge, and evapotranspiration.

TABLE 19-2
GROUNDWATER DISCHARGE IN CACHE COUNTY[8]

	(acre-feet/year)	(percent)
Pumped from wells	24,000[a]	14
Discharge to streams and springs	83,000[b]	49
Losses to evapotranspiration	63,000	37
Subsurface outflow	Negligible	
Total	170,000	100

[a]For residential, commercial, industrial, irrigation, and livestock use (See Table 5-4).
[b]Including springs developed for residential/commercial use. Most community drinking water sources are springs (See Section 11.2.2).

Chemical analyses of water from the principal aquifers show it is of generally good quality. The quality has not changed significantly since 1941. Average TDS (total dissolved solids) values are less than 400 mg/L in the southern and eastern portions of the valley. The TDS values increase towards the west and north portions of the valley, with concentrations generally between 400-800 mg/l in the Benson, Newton, and Clarkston areas. Increases in TDS generally occur as the water moves from recharge areas near the mountains toward the discharge areas on the valley floor. Calcium, magnesium, and bicarbonate are the major chemical constituents present in the water.

19.2.3 Box Elder County

The Box Elder County portion of the basin is described as that portion east of the Promontory Mountains. The area covers about 800 square miles (See Section 3).

Like Cache Valley, the Box Elder County region is a structural basin into which the Bear River has deposited a delta.[9] Groundwater occurs in the sand and gravel beds of the delta and in the carbonate sedimentary bedrocks of the adjacent mountains.

Three main aquifers are within this area. The major one, from which most of the developed wells obtain their water, is a deep, confined aquifer. Unconfined and localized perched aquifers lie above the confined zones. Areas near the mountain front are typically unconfined or on the outer fringes of the confining system. The highest yielding wells penetrate the clastic geologic materials of these areas. Local perched aquifers are present in Box Elder County, but both the quantity and quality are highly variable. Therefore, little development of these zones has taken place.

Box Elder County is hydrologically complex. It is an area of transition, with cold, fresh groundwater at the upstream end (at higher altitudes) and generally warm, very saline groundwater at the downstream end near the Great Salt Lake. A wide range of hydrologic conditions exists through the area between.

Groundwater within the area is used for irrigation, public supply, livestock, and domestic use. Public supply provides municipal use for at least 22 communities in Box Elder County. The 1990 population of the entire county was 36,485. At present, all of the municipal water systems are supplied from springs and wells. Some of the distribution systems cover large rural areas because local groundwater is not always suitable for domestic use. According to a recent study, annual municipal and industrial use is 12,800 acre-feet and 3,500 acre-feet, respectively.[10]

Groundwater use for irrigation in Box Elder County occurs mainly in two areas: Brigham City-Perry and the "Bothwell Pocket," west of Tremonton. In the Brigham City-Perry area, moderate additional development of good quality groundwater is feasible. But in the Bothwell Pocket, additional development is marginal, and the State Engineer has closed the area to further pumping. Sixty-four percent of recharge to the groundwater system in Box Elder County occurs from infiltration of precipitation, and infiltration directly from stream channels. Another 27 percent occurs from irrigation seepage, and nine percent from subsurface flow. Total recharge to Box Elder County is estimated to be 315,000 acre-feet per year.

Groundwater discharge occurs from the pumping of wells; seepage of water to the surface, discharge by subsurface flow to springs, drains, or streams, and by evapotranspiration from high-water-table areas. As shown in Table 19-3, approximately 315,000 acre-feet of water is discharged annually in Box Elder County.

More information about the groundwater storage characteristics of Box Elder County is needed, but it appears that only a small percentage of stored water could be beneficially developed. This is because the outer fringes of the Great Salt Lake are highly saline. Any marked decreases in the groundwater levels could result in this poorer quality groundwater moving to inland groundwater reservoirs.

TABLE 19-3
GROUNDWATER DISCHARGE IN EASTERN BOX ELDER COUNTY[8]

	(acre-feet/year)	(percent)
Pumped from wells	4,000[a]	1
Discharge to streams	210,000[b]	67
Subsurface outflow	1,000	0.3
Evapotranspiration	100,000	32
Total	315,000	100

[a]For residential, commercial, industrial, irrigation and livestock use (See Table 5-4).
[b]Including springs developed for residential/commercial use. Most community drinking water sources are springs (See Section 11.2.2).

Chemical quality varies from "excellent" to "unfit for most uses" because of salinity. In general, the quality improves with distance from and elevation above the Great Salt Lake. Analyses show that dissolved solids vary from 88 to 122,000 mg/1, depending on location. Calcium, magnesium, and bicarbonate are the predominant ions in the water near the edges of the mountains.

19.3 PROBLEMS, NEEDS, AND ISSUES

Several important problems and issues related to groundwater have been identified. These problems and issues include:

1. Proposal to export groundwater from Cache Valley to Box Elder County,

2. Reduction of flow and pressure from flowing wells by increased groundwater use,

3. Urban development in recharge areas,

4. Protection of groundwater from contamination.

In October 1984, the governor issued an Executive Order that defined Utah's groundwater policy and directed the Department of Health to develop a protection strategy. Subsequently, a draft "Ground Water Quality Protection Strategy for the State of Utah" was published in June 1986.[11] This document is part of the State Water Plan by reference.

At present, about 50,270 acre-feet/year (or 98 percent) of the 51,170 acre-feet of residential and commercial water used in the basin (See Table 11-7) is from springs and wells, and this trend will probably continue. By the year 2010, the municipal and domestic requirement is expected to increase by nearly 14,000 acre-feet, with about the same percent expected to come from groundwater. Most of the increased use of groundwater will probably be in Cache Valley, where the supply of high-quality groundwater is greatest.

Currently, all of the industrial use in the basin (approximately 10,310 acre-feet/year) is from groundwater supplies. It is expected that groundwater for agriculture (about 22,300 acre-feet/year) will probably remain constant, but municipal and domestic use is expected to continue to increase.

19.4 RECOMMENDATIONS

To the extent a groundwater supply is available, and water quality remains good, groundwater development in Cache and Rich counties should continue to satisfy future high-quality needs. Ongoing studies should define what level of new development can occur without significant interference with existing water rights.

Cooperative development and distribution of surface water and groundwater supplies is recommended in order to meet the future growth of municipal and industrial requirements in the basin.

In Box Elder County, further development of groundwater for residential/ commercial use cannot be ruled out. Geophysical surveys and test-drilling might locate good quality groundwater. If available, these new sources can be developed to increase the fresh groundwater supplies of the lower Bear River area, where fresh water resources are somewhat limited. However, new wells must be approved by the State Engineer, who has closed some portions of Box Elder County to further groundwater development.

To safeguard groundwater supplies throughout the basin, all water resources and water user entities should cooperate and support the state's groundwater quality protection strategy.

19.5 REFERENCES

In addition to the references listed below, Section 19 of the Utah State Water Plan, January 1990, discusses the relationship of groundwater to the total water needs and presents recommendations on the groundwater issues.

1. "Bear River Investigations, Status Report," U.S. Bureau of Reclamation, June 1970.

2. "Bear River Development-Present Water Supplies, Uses & Rights" Hansen, Allen & Luce, Inc., June 1991.

3. "Hydrologic Inventory of the Bear River Study Unit," by Haws and Hughes, Utah State University for the Utah Division of Water Resources, February 1973.

4. "Multiobjective Interagency Study, Bear River Basin, Water and Related Land Resources," Utah Division of Water Resources, December 1976.

5. Based on several telephone interviews with experienced U.S. Soil Conservation Service engineers in Logan and Randolph, March 1991.

6. "Groundwater Resources of Cache Valley, Utah and Idaho," by Bjorklund and McGreevy, U.S. Geological Survey, for Utah Division of Water Rights, Technical Publication No. 36, 1971.

7. "Groundwater Conditions in Utah, Spring of 1990," by Herbert et. al, U.S. Geological Survey, in cooperation with Utah Division of Water Rights, Cooperative Investigations Report No. 30, 1990.

8. "Wasatch Front Total Water Management Study," Utah Division of Water Resources and U.S. Bureau of Reclamation, February 1990.

9. "Bear River Water Development Study" prepared for Bear River Water conservancy District and Tremonton City Corporation, by Valley Engineering, Inc. and Hansen, Allen and Luce, Inc., February 1989.

10. "Groundwater Resources of the Lower Bear River Drainage Basin, Box Elder County, Utah," by Bjorklund and McGreevy, U. S. Geological Survey, for the Utah Division of Water Rights, Technical Publication No. 44, 1974.

11. "Ground Water Quality Protection Strategy for the State of Utah," by Barnes and Croft, Utah Department of Health, June 1986.

State Water Plan ■ BEAR RIVER BASIN

Prepared by the State Water Plan Coordinating Committee

Department of Natural Resources - Division of Water Resources,
Division of Water Rights, Division of Wildlife Resources,
Division of Parks and Recreation

Department of Environmental Quality - Division of Drinking Water,
Division of Water Quality

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